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Perspectives on New Nuclear Monitoring Challenges

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June 2005
IDA Document NS D-3158
Log : H 05-001192

This work was conducted under contract DASW01 04 C 0003, Task AP-2-2276, for the ATSD/NCB/CD&TR. The publication of this IDA document does not indicate endorsement by the Department of Defense, nor should the contents be construed as reflecting the official position of that Agency.

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Perspectives on New Nuclear Monitoring Challenges

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Presentation to the Commission on Seismology and Geodynamics

June 6, 2005

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Starting Point

“LEHRER: Just for this one-minute discussion here, just for whatever seconds it takes: So it's correct to say, that if somebody is listening to this, that both of you agree, if you're reelected, Mr. President, and if you are elected, **the single most serious threat you believe**, **both of you believe, is nuclear proliferation**?

BUSH: In the hands of a terrorist enemy.”

Presidential Candidate’s Debate, University of Miami, Coral Cables, Florida, September 30, 2004
Commission on Presidential Debates (emphasis added)

What nuclear monitoring is needed
to counter 21st century nuclear threats?

Topics

What are the 21st century nuclear threats?

What are the 21st century nuclear monitoring challenges?

What are the implications for seismology and geodynamics research to improve nuclear monitoring capabilities?

This presentation presents personal views that should not be attributed to any organization

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Cold War Nuclear Threats

During the cold war, the principal threat was posed by the nuclear capabilities of the Soviet Union

- This is the challenge that our currently deployed strategic forces were developed to counter

While attention was also given to Chinese nuclear capabilities, in terms of deployed nuclear forces, China was at least an order of magnitude less capable than the Soviet Union

Proliferation threats were recognized and addressed using diplomatic means

Nuclear threats have changed

To a significant extent, the cold war nuclear threat was the Soviet arsenal. While other states' nuclear capabilities were of concern, priority was given to offsetting the Soviet Union's significant nuclear capabilities.

Four Challenges

IRREGULAR

State and non-State adversaries employ unconventional means to counter U.S. advantages in the traditional arena.

Examples: terrorism, civil war

CATASTROPHIC

Employment of Weapons of Mass Effect (WME) or methods producing WME-like results

Examples: September 11, 2001; rogue state use of WME

More likely

Lower vulnerability

Higher vulnerability

Less likely

TRADITIONAL

Military forces in well-established forms of conflict and competition

Examples: conventional air, land, and sea attacks; nuclear forces of established nuclear powers

DISRUPTIVE

Breakthrough methods or technologies.

Possible examples: bioterrorism, cyber operations, directed energy and other emerging fields

The United States has faced nuclear threats for a half-century. These threats have changed, necessitating new approaches for nuclear monitoring. The slides that follow outline the evolution of nuclear threats within each of the four types of strategic challenges.

This framework is commonly used today within DoD to provide an overview of the different types of threats the United States faces in the 21st century. This depiction is based on:

- United States Joint Forces Command, The Joint Operating Environment--Into the Future, draft, January 2005, pp. 10-11.
- Facing a New Reality. Nontraditional threats change Pentagon's weapon priorities. Armed Forces Journal International, December 2004, p. 21.

A useful overview of the implications that this new emphasis on non-traditional threats has for DoD strategic planning is provided in a recent article by Dov Zakheim, Under Secretary of Defense (Comptroller) in the first term of the current Administration -- The Quadrennial Defense Review: Some Guidance Principles, Heritage Lectures, February 1, 2005.

A concomitant development in national strategy has been a new emphasis on proactive measures to counter nuclear and other WMD threats before they are unleashed, e.g., The National Security Strategy of the United States, 2002, p. 14.

Evolution of Traditional Nuclear Challenges

Nuclear challenges have changed in important ways over a half-century

This and the following charts depict the evolution of challenges, focusing on:
- 1980s (late cold war)
- 1990s (pre-September 11th efforts to define and respond to new threats)
- 21st century (responding to new threats)

Much of the architecture for nuclear monitoring in use today was developed to counter traditional cold war era challenges

Lower vulnerability

TRADITIONAL

Less likely

1980s
- Deter Soviet strike against United States
- Deter Soviet aggression against NATO

1990s
- Mixed success in establishing a new strategic relationship with the Russian Federation

21st century
- Cold war era strategic confrontation regarded as unlikely
- Traditional types of major conventional war expected to be less likely

During the cold war, priority was given to threats posed by the Soviet Union.

Current expectations are that a cold war-like strategic confrontation with a nuclear peer adversary is unlikely in the near future. It is also commonly assumed that the United States has conventional superiority and would prevail in the event of a major conventional war.

One rationale for maintaining some of the capabilities developed to counter the traditional nuclear and large conventional war threats is that they make it difficult for potential adversaries to become peer adversaries, as would not be the case, for example, if the United States had a much smaller nuclear posture.

Evolution of Irregular Nuclear Challenges

IRREGULAR

More likely

Lower vulnerability

Terrorist nuclear/Radiological Dispersal Device (RDD) threats constitute irregular nuclear challenges

1980s
- Cold war era domestic threats and threats abroad
- DoD lead for protection of Defense facilities and materials; DoD support to Lead Federal Agencies

1990s
- Loose nukes in former Soviet Union

21st century
- al-Qaeda RDD threat
- Increased concern with security of nuclear sources and materials, world-wide
  -- Important DoD roles in efforts to bring materials under control and to prevent and interdict terrorist access, e.g., Proliferation Security Initiative
- United Nations Security Council Resolution 1540

"...the single most serious threat you believe, **both of you believe, is nuclear proliferation**?
BUSH: In the hands of a terrorist enemy."

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It is important to note that what follows varies from some presentations of the four challenges framework by listing some potential nuclear threats under the Irregular heading. This calls attention to nuclear terrorist threats that have been of concern since the 1970s. This also responds to the fact that some Irregular RDD threats, e.g., a radiological dispersal device detonated within a building, would not necessarily have society-scale Catastrophic effects.

During the 1970s, domestic nuclear threats prompted establishment of the Department of Energy Nuclear Emergency Search Team (NEST). Then and today, the Department of Defense was responsible for protecting its facilities and nuclear materials in its custody. In addition, DoD supports Lead Federal Agencies in domestic and foreign responses. During the 1990s, additional potential threats received attention. Emphasis was given to measures to improve the security of former Soviet nuclear weapons and materials -- Cooperative Threat Reduction.

Documentation exists concerning al-Qaeda's interest in RDD weapons, e.g., Jack Boureston, Assessing Al Qaeda's WMD Capabilities, *Strategic Insights*, September 2, 2002, National Security Affairs Department, Naval Postgraduate School, Monterey, CA.

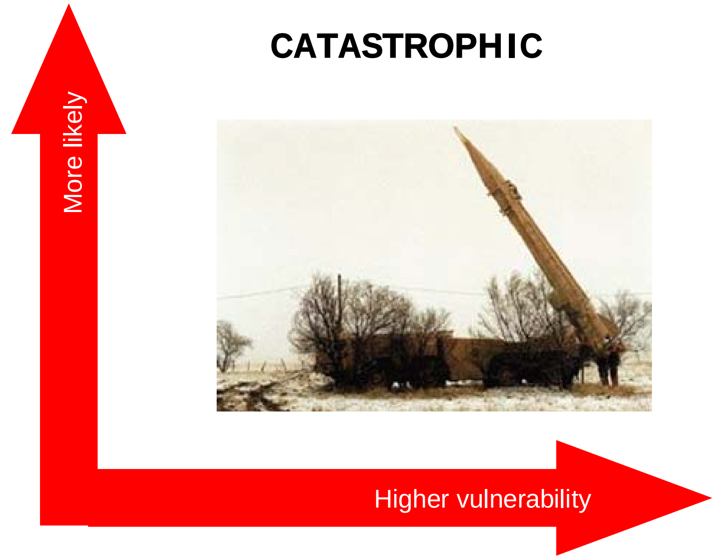
UN Security Council Resolution 1540, 28 April 2004, establishes new international law to prevent non-State actors from acquiring nuclear, chemical, or biological weapons and their means of delivery. This resolution is available at:

http://www.un.org/Docs/sc/unsc_resolutions04.html

The Proliferation Security Initiative (PSI) is a multinational effort to interdict transfer or transport of WMD, delivery systems, and related materials to and from states and non-state actors of proliferation concern. A White House fact sheet is available at:

http:/www.state.gov/t/np/c10390.htm

Evolution of Catastrophic Nuclear Challenges



1980s
- Proliferation countered using alliances and diplomatic means, e.g., Nuclear Nonproliferation Treaty (NPT)

1990s -- Many developments:
- Post-DESERT STORM understanding of Iraqi program
- Negotiations with North Korea concerning its programs
- Overt Indian and Pakistani tests
- South Africa's revelations

21st century
- Proliferation networks, e.g., A.Q. Kahn
- Proliferant capabilities more difficult to identify, impede, or counter
- Regional contingencies may include nuclear-capable adversaries
- New policy measures, e.g., Proliferation Security Initiative (PSI)

"...the single most serious threat you believe, **both of you believe, is nuclear proliferation**?
BUSH: In the hands of a terrorist enemy."

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There were important developments during the 1990s that impact understanding of potential catastrophic nuclear threats:

- Following DESERT STORM, evidence was obtained concerning the status of Iraqi nuclear proliferation that was not available prior to the war.
- North Korea announced its intention to withdraw from the NPT, and then "suspended" its withdrawal. Negotiations have occurred in a variety of formats, including the six state discussions.
- In 1998, India and Pakistan tested nuclear devices in a way that contradicted some expectations concerning proliferant nuclear testing. These tests were publicly announced, not clandestine.
- South Africa's announcement that it had eliminated its nuclear weapons program was the first indication for some that this program existed.

21st century proliferant challenges are more difficult to counter for a number of reasons:

- More states have progressed to the point of virtual proliferation in their NPT treaty compliant civilian nuclear programs
- Few states of concern have agreed to and implemented the International Atomic Energy Agency additional protocol to provide improved transparency
- There appears to be increased use of difficult to monitor proliferation networks
- There appears to be increased used of underground facilities to obscure activities

Terrorist nuclear threats of the type emphasized in the quotation can be Irregular, e.g., use of RDD by terrorist groups, or Catastrophic, e.g., nuclear weapon threats posed by regional states.

Evolution of Disruptive Nuclear Challenges

1980s -- Concern with Soviet developments that might disrupt strategic nuclear balance

- ABM breakout
- New deployments, e.g., new generations of heavy-lift strategic missiles, SS-20, Backfire bombers
- Potential novel strategic weapons

1990s -- Attention to new types of potential disruptive threats

- Cyber attacks
- Radio frequency and electronic warfare threats (some of which might involve nuclear weapons)

21st century--Threats include

- Nuclear attacks (one/few detonations) with Electromagnetic Pulse (EMP) effects that damage the functioning of American society or place our electronics-dependent forces at risk

Potential disruptive threats were recognized during the late cold war, with particular attention given to Soviet developments and deployments that might impact the strategic balance. ABM breakout was a key scenario of concern. Also of concern were developments in Soviet force structure, e.g., successive generations of heavy-lift strategic missiles.

New types of potential challenges received emphasis during the 1990s. Concern regarding the functioning of computer systems (the Year 2000 problem) reinforced attention on potential cyber attack threats.

The Congressionally chartered Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack concluded that nuclear EMP attack can hold the functioning of American society at risk and/or damage the ability of the United States to project influence and military power. Its unclassified report to Congress has been posted on a number of Internet sites, including:

<http://www.globalsecurity.org/wmd/library/congress/2004_r/04-07-22emp.pdf>

Assumed Parameters for Nuclear Monitoring (1)

In the past, it was sometimes assumed that monitoring nuclear testing was a problem with understood parameters

For the Soviet Union/Russian Federation, the treaty compliance tasks were to:

- Detect testing in prohibited (not underground) environments
- Monitor testing at known test sites to ensure yields were below the 150 kiloton threshold defined in the Threshold Test Ban Treaty

Nuclear weapon test monitoring isn't a new problem. A number of scientific disciplines have been applied in support of nuclear monitoring for more than a half-century. Influenced in large part by agreed treaties and past negotiations, common assumptions have developed concerning the parameters that apply for such monitoring.

Assumed Parameters for Nuclear Monitoring (2)

For the Russian Federation and China (which have self-imposed moratoriums on nuclear testing) and other states that have expressed support for a Comprehensive Test Ban Treaty (CTBT), e.g. Iran, there is interest in determining if such states engage in nuclear test activities that are inconsistent with the CTBT

- The U.S. interpretation of the CTBT is that it prohibits all nuclear tests that produce a hydrodynamic yield

Assumed Parameters for Nuclear Monitoring (3)

For potential nuclear proliferants, it is sometimes assumed that:

- Initial testing is likely to be clandestine
- Testing is most likely to be on national territory,
- States design and produce their own warheads -- a complex activity with a number of potential signatures that requires years of effort
- Testing will be necessary to confirm weapon performance
- Testing will be an integral part of the development effort and a leading indicator

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Reconsidering Parameters for Nuclear Monitoring (1)

In the past, it was sometimes assumed that monitoring nuclear testing was a problem with understood parameters

For the Soviet Union/Russian Federation, the treaty compliance tasks were to:

- Detect testing in prohibited (not underground) environments

- Monitor testing at known test sites to ensure yields were below the 150 kiloton threshold defined in the Threshold Test Ban Treaty

These assumptions continue to hold so long as the Limited Test Ban Treaty and Threshold Test Ban Treaty continue in force

Reconsidering Parameters for Nuclear Monitoring (2)

For the Russian Federation and China (which have self-imposed moratoriums on nuclear testing) and other states that have expressed support for a Comprehensive Test Ban Treaty (CTBT), e.g. Iran, there is interest in determining if such states engage in nuclear test activities that are inconsistent with the CTBT

- The U.S. interpretation of the CTBT is that it prohibits all nuclear tests that produce a hydrodynamic yield

Other parties may not agree with the U.S. zero-yield interpretation:

- *The CTBT text does not define "test" and does not contain the phrase "zero yield"*

- *A Russian book published in 1997 stated that explosive tests in which the nuclear energy released is comparable to the high-explosives in the device are hydronuclear tests, not nuclear tests**

*Senator Trent Lott, Congressional Record -- Senate, October 8, 1999, S12289.

> [Senator Lott]... Hydronuclear testing is very low-yield testing, and is particularly useful in assessing nuclear weapon safety issues. Until the Clinton administration adopted its “zero-yield” position, it held that hydronuclear tests would be permissible under a comprehensive test ban treaty. After the administration adopted zero-yield as its position, though, American representatives declared hydronuclear testing to be contrary to this standard. Other countries, such as Russia, however, have declared hydronuclear testing to be consistent with its understanding of the treaty. Victor Mikhailov, formerly the Russian Minister of Atomic Energy and currently the First Deputy Minister at that ministry, stated on April 23, 1999, that the Russian nuclear program has to focus on, in his words, “three basic directions” in a CTBT environment: “new computer equipment, nontest- site ‘simulation’ experiments, and so-called test-site hydronuclear experiments, where there is practically no release of nuclear energy.” Neither Russia nor, for that matter, China, has agreed even to the U.S. definition of what constitutes a hydronuclear test. After Russia signed the Comprehensive Test Ban Treaty in 1996, Arzamas-16, one of Russia's two nuclear weapons labs, published a book in 1997 entitled Nuclear Tests of the USSR. According to this book, “Explosive experiments with nuclear charges in which the amount of nuclear energy released is comparable to energy of the HE [high explosive] charge, belong to the category of hydronuclear tests, and they also are not nuclear tests * * *.” In plain English this means that one of Russia's two nuclear design labs does not consider low-yield testing to be a violation of the Comprehensive Test Ban Treaty. The Russian position is not without merit, as the treaty's failure to define the meaning of the word “test” or even to include the phrase “zero-yield” gives rise to these kinds of fundamental ambiguities...

—Senator Trent Lott, *Congressional Record – Senate*, October 8, 1999, S12289.

The U.S. negotiator for the CTBT, Ambassador Stephen Ledogar, has counter-argued that the Russians in fact did make a categorical commitment to a comprehensive prohibition of any nuclear explosion.

A summary of the consideration given to this question during Senate deliberations on the CTBT is provided in: Rob Mahoney, Nuclear Test Limitation Issues. IDA D-2452, April 2000, p. 2-4+.

Reconsidering Parameters for Nuclear Monitoring (3)

- Initial testing is likely to be clandestine

  India and Pakistan publicized their 1998 nuclear tests

- Testing is most likely to be on national territory

  If technical objectives are minimal -- limited to confirmation that a nuclear detonation occurs -- testing could take place anywhere, and, if not on national territory, might be more difficult to attribute

  The first demonstration of nuclear capability might be on a target, much as the Hiroshima did not have a nuclear test with yield prior to its employment

- States design and produce their own warheads -- a complex activity with a number of potential signatures that requires years of effort

  Supplier networks can transfer the development work already accomplished by others

- Testing will be necessary to confirm weapon performance

  The A.Q. Kahn network is reported to have supplied Libya with bomb blueprints. If a previously tested design is built to specifications, no additional testing may be needed.

- Testing will be an integral part of the development effort and a leading indicator

  Testing may not be needed or may be a lagging indicator -- accomplished after a stockpile has been developed in order to send a signal and/or confirm performance

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Implications for Nuclear Monitoring

Legacy nuclear monitoring capabilities were initially developed to address the Soviet threat.

Over time, these capabilities were adapted to monitor proliferation, to include verification of the Nuclear Nonproliferation Treaty and the Comprehensive Test Ban Treaty

Monitoring capabilities were developed with reference to requirements as perceived in the past

- Current efforts, for example those in the NNSA/AFRL/SMDC RFP are necessary but not sufficient to defeat 21st Century threats

- Greater emphasis is needed on monitoring under-development capabilities, to include credible nuclear capabilities that might be achieved without testing

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The RFP being cited is the Solicitation for Proposals for the Joint National Nuclear Security Administration/Air Force Research Laboratory/Army Space and Missile Defense Command Broad Agency Announcement for Fiscal Year 2006 Regarding Nuclear Explosion Monitoring Research and Engineering, DE-SC52-05NA26703 available at:

<https://www.nemre.nnsa.doe.gov/cgi-bin/prod/coord/index.cgi?Page=Proposals>.

Potential Implications for Seismology and Geodynamics Research (1)

Continued need for monitoring to support Threshold Test Ban Treaty

Continued need for monitoring to support the Nuclear Nonproliferation Treaty, and to identify testing by states that are not parties to the NPT

> For these purposes, maintenance and modernization of existing capabilities may suffice

Potential Implications for Seismology and Geodynamics Research (2)

Current Policy is that the United States will not become a State Party to the Comprehensive Test Ban Treaty (CTBT)

There is interest in monitoring states that have expressed support for the CTBT to act in manners consistent with that agreement

- A key point here is that others may regard some types of testing with yield as being allowed under a CTBT
- Capabilities for monitoring very low yield testing are of interest for this and other reasons
- Potential venues beyond the traditional test sites need to be monitored

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Potential Implications for Seismology and Geodynamics Research (3)

Some of the threats to be monitored are elusive

Alternative capabilities for monitoring smaller events are of interest

- This could involve different sensors and sensor locations

There is a need to integrate multiple types of sensors that operate in a complex network

- Seismological assessments might contribute to the characterization of events initially detected by other sensors

Potential Implications for Seismology and Geodynamics Research (4)

Seismological and geodynamics research may be able to make significant contributions, given these communities' expertise in:

- Collection of large volumes of information from complex sensor networks
- Management and analysis of large databases
- Integration of multiple time-stamped inputs to identify and characterize signals within noisy environments

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED *(From–To)*
June 2005	Final	April 2005–June 2005

4. TITLE AND SUBTITLE

Perspectives on New Nuclear Monitoring Challenges

5a. CONTRACT NUMBER
DAS W01 04 C 0003

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Rob Mahoney

5d. PROJECT NUMBER

5e. TASK NUMBER
AP-2-2276

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Institute for Defense Analyses
4850 Mark Center Drive
Alexandria, VA 22311-1882

8. PERFORMING ORGANIZATION REPORT NUMBER

IDA Document NS D-3158

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

ATSD/NCB/CD&TR
1515 Wilson Boulevard, Suite 720
Rosslyn, VA 22209

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution unlimited. (29 September 2005)

13. SUPPLEMENTARY NOTES

14. ABSTRACT

This paper builds on the IDA work on new challenges in monitoring the development, testing, and proliferation of nuclear weapons. The paper concentrates on those aspects of monitoring which will continue to be supported by geophysical measurements. It is a presentation to the National Academy Committee on Seismology and Geodynamics.

15. SUBJECT TERMS

monitoring nuclear tests, nuclear weapons development and proliferation

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Dr. Steve Mangino
a. REPORT Uncl.	b. ABSTRACT Uncl.	c. THIS PAGE Uncl.	SAR	35	19b. TELEPHONE NUMBER *(include area code)* 703-588-1983

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18